COMPARATIVE ANALYSIS OF THE FUNCTIONAL OUTCOME OF COMMINUTED INTRA-ARTICULAR FRACTURES OF DISTAL TIBIA FIXED USING EXTERNAL FIXATOR vs LOCKING PLATE

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ABBREVIATIONS

AITFL - Anterior Inferior Tibiofibular Ligament

ADL - Activity of Daily Living

AO- Arbeitsgemeinschaft fur Osteosynthesefragen

AOFAS - American Orthopaedic Foot & Ankle Society

CT – Computed Tomography

DTLCP- Digital Tibial Locking Compression Plate

LCP - locking compression plates

IMIL- Intramedullary Interlocking

IMN – Intra-medullary Nailing

LISS- Less Invasive Stabilization System

MIPPO - Minimally invasive percutaneous plate osteosynthesis

OTA - Orthopaedic Trauma Association

ORIF - Open reduction and internal fixation

PITFL - Posterior Inferior Tibiofibular Ligament

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INTRODUCTION

Introduction

The tibia's distal end is more superficial in character. The vascular supply and soft tissue covering of the bone in this location are both quite low. Because of the varying involvement of the articular surface, soft tissue injury, and the limited blood supply, injuries to this area cause higher morbidity. Distal tibia intra-articular fractures are often known as 'pilon fractures' or 'tibial plafond fractures.' With the recent surge in high-velocity injuries, treatment has grown more difficult. The selection of fixing procedures is heavily influenced by fracture patterns, soft tissue injuries, and bone quality. [1]

Distal tibia fractures are frequently caused by high-velocity accidents that cause severe soft-tissue injury. Surgeons must decide whether to prioritise soft tissue healing or anatomic reduction and articular congruity when treating these fractures. Due to insufficient soft tissue covering, decreased vascularity of the distal tibia area, and related soft tissue injuries, orthopaedicians have been confronted with difficulties such as mal-union, delayed union, non-union, and wound dehiscence. Anatomic reduction of the articular surface, fracture alignment restoration, correct soft tissue manipulation, and early ankle movement have all been found to be beneficial in the treatment of distal tibial fractures. [2]

Intra-articular fractures at the distal end of the tibia, also known as pilon fractures, occur for 5% to 7% of all tibial fractures.[1] A complete articular fracture confined inside a fragile soft-tissue envelope presents a unique surgical challenge. Internal fixation, external fixation with or without limited internal fixation, and primary ankle arthrodesis are among treatment possibilities. [2]

The patient's general state of health, soft-tissue condition, and fracture comminution, as well as the surgeon's expertise, typically affect care, and notably the scheduling of surgery.[3] The surgical objectives are to repair the plafond's articular surface, restore limb alignment, and safeguard the soft-tissue envelope. [4]

Despite advancements in non-surgical and operative therapy, distal tibia fractures remain a contentious topic. The goal of distal tibia fracture treatment is to correct the fracture, adjust limb length, and allow for early functional recovery. Because of the significant complications, distal tibia fractures continue to be among the most difficult to treat. [5]

Modern lifestyle and a rise in high-speed road traffic accidents, particularly involving two-wheelers, have resulted in an increase in the prevalence of complicated distal tibia fractures, making treatment more challenging. Treatment of these fractures is traditionally considered difficult due to the following factors: less soft tissue coverage over the bone, comminution of the weight bearing articular surface of the distal tibia, high chances of nonunion (5% to 6.6%), difficulties in reduction and internal fixation, and the possibility of ankle arthrosis. [6]

They are becoming more common as the number of road traffic accidents increases. It accounts for 1% of all lower extremity fractures, 10% of tibial fractures, 0-8% of bilateral fractures, and 5% of compartment syndrome. The mechanism of damage is axial stress caused by the talus striking the lower end of the tibia forcefully. [7] The articular surface damage, metaphysealcommunition, joint impaction, and accompanying soft tissue injuries are all determined by the axial force on the distal tibia. [8]

This sort of damage requires careful treatment of the soft tissues as well as a proper reduction method. The clinical evaluation of the damage is critical for controlling the difficulties and properly repairing the bones. The procedure of repairing such a fracture involves many modalities, including soft tissue dehiscence, reduction of articular fragmentation, and secure fixation through external implants. The use of olive wires allows for the application of multi-directional stresses to reduce the spiral fracture. Care professionals must take particular precautions while treating fractures of the distal region of the tibia because they include a limited group of fractures that are difficult to manage and classify.[9]

The fracture pattern and treatment method for intra-articular fractures of the distal end of the tibia are determined by the mechanism and severity of the injury. An axial compression mechanism's impact forces the articular surface proximally into the metaphysis, causing metaphyseal comminution. Fibular fractures are often found. Low-energy torsional injuries result in less articular comminution and bigger fracture pieces that stay in contact with the subchondral bone. [9] On axial imaging, many investigations have also confirmed the morphology of three main components (anterior, posterior, and medial) in a Y-shaped pattern. [10] This predicted fracture pattern is aided by ligamentous attachments to the distal tibia. The anterior or Chaput fragment is connected to the anterior inferior tibiofibular ligament (AITFL), the posterior or Volkmann fragment to the posterior inferior tibiofibular ligament (PITFL), and the medial malleolar fragment to the deltoid ligament. Fractures that retain their regular alignment or fractures that lack the characteristic Y-shaped pattern might indicate ligament rupture.

Open fractures account for around 20% of intra-articular fractures. High-energy injuries are often accompanied by extensive soft tissue damage, which may be a significant risk factor for

wound complications and deep infections. [9] However, the level of soft tissue damage does not necessarily correspond with the degree of fracture comminution. [10]

The position of the foot at the time of impact determines the location of the articular part of the fracture. Fractures of the distal part of the tibia include the metaphysealflare, posing the challenge of less implant contact, resulting in less stability and higher malalignment. This kind of misalignment produces significant mechanical changes in the ankle, resulting in increased pain and functional disability.[11]

Treatment of a distal tibia fracture often causes in problems such as malunion, non-union, and ankle surface. The tibial fracture requires surgical treatment due to high intensity impact and early tissue mobility. The treatment objective is to achieve a healed, well-aligned, functional range of motion in the ankle joint. In treating complicated fractures, the fracture reduction technique has shown to be effective. The major goal of this approach is to use stable plate fixation while preserving fracture biology and soft tissue problems. In the given setting, the use of locking plates is advantageous for regulating the distal section of the tibia.[11]

Surgical fixation of distal tibia fractures requires careful preoperative planning due to fracture pattern, soft tissue damage, bone quality, and articular involvement, all of which impact fixing method selection. Several treatments have arisen, including conservative external fixation, hybrid external fixation, and intramedullary nailing.

External fixation may be beneficial in open fractures with soft tissue injuries that limit nail or plate fixation, but it can result in incorrect reduction, a high risk of malunion or nonunion, pin tract infection, and pin loosening.[12] In terms of intramedullary interlocking nailing, achieving

a secure fixation with a nail in the distal tibia may be problematic due to the hourglass form of the intramedullary canal, which precludes a tight endosteal fit and impairs torsional and rotational stability.

External fixators are a novel development in this industry. It is made up of plate and screw systems, with the screws fastened into the plate at a predetermined angle. Because the plate does not need to be securely placed on the bone to stabilise the fracture, screw locking reduces plate and bone contact. [13]

The locking plates feature internal and exterior fixation biomechanical qualities that enable higher holding force and fixed angular holding. Furthermore, novel procedures for treating such fractures include minimally invasive percutaneous plate osteosynthesis, which seeks to minimise periosteal dissection and hematoma disruption, solid anatomical fixation, and early mobilisation. These types of therapeutic approaches are having a substantial influence on the management of distal tibial high-energy fractures. The study will offer data on the outcome of an intraarticular fracture of the distal tibia treated with an external fixator. [14]

This kind of injury is difficult to treat due to its subcutaneous position, fragile blood supply, and closeness to the ankle joint. The appropriate diagnosis of injuries and execution of the treatment plan aids in the management of difficulties and the provision of better care services to patients. The first radiography is essential to determine the specific fracture pattern associated with the injury. Because the nail cannot create a tight fit at the distal fracture site, IM nailing has been associated with greater incidence of mal-union, affecting the therapeutic process. [15]

The device functions as a flexible elastic fixation mechanism that promotes callus production. The anatomical form avoids first fracture displacement and enables for more equal distribution of angular and axial loads across the plate. Because the procedure was minimally invasive, the periosteal blood flow of the bone and the fracture haematoma were not disrupted.

AIM & OBJECTIVE

AIM

Aim:

To compare the functional outcome of the patients with intra-articular distal tibia fracture managed with external fixation and patients with intra-articular distal tibia fracture managed with locking plate.

OBJECTIVES

Objectives:

A. Measurement of functional outcome of fracture patients managed with external fixation using KATZ daily living activity score

B. Measurement of functional outcome of fracture patients managed with locking plate using KATZ daily living activity score

C. Comparison of functional outcome between both modalities of intervention

D. To recommend the intervention based on study findings

REVIEW OF LITERATURE

Review of literature

Fractures have been recognized and well recorded in history. Knowledge of fracture treatment dates back to Egyptian mummies of 2700 BC. External splintage was the only option for the management of fractures for thousands of years. Around 5000 years ago, Egyptians used palm bark and linen bandages. Wood, Clay and lime mixed with egg white were used.

In 1897, the first modern external fixator was developed by Dr Clayton Park Hill. In 1906, Dr. AlbitLambotte designed a similar external fixator. In 1934, Dr Roger Anderson developed a frame with transfixation pins. In 1938 Dr. Raoul Hoffman invented the Hoffman fixator, which was later modified into the Hoffman Vidal system by Dr. Vidal and Dr. Adrey by using multiplanar frame to increase the rigidity. However, this frame was too rigid and static and thwarted union.

Pilon is a French term used to describe a fracture of the distal tibia. Destot coined the term pilon, as he thought that the distal tibial metaphysic resembled a pharmacist's pestle. Plafond is a French term described by Bonin, Referring to the distal tibial articular surface as the roof of the ankle joint. In a study of 84 patients, that established the open reduction and internal fixation with screws and plate as the standard, the authors with a nine-year follow up reported 74% good functional results.

The principles of treatment included:

a. Re-establishment of the fibular length.
b. Re-construction of the lower articular surface of tibia.
c. Placement of metaphyseal bone graft; and
d. Stabilisation of the medical aspect of tibia using a plate.

Anatomy of tibia

The tibia is a medial and large long bone of the lower extremity, connecting the knee and ankle joints. It is considered to be the second largest bone in the body and it plays an important role in weight bearing.[16] Osteologic features of the tibia include medial and lateral condyles, the tibial plateau, the tibial tuberosity, the soleal line, the medial malleolus, and the fibular notch.

Tibial plateau

The proximal end of the tibia terminates in a broad, flat region called the tibial plateau. The intercondylar eminence runs down the midline of the plateau, separating the medial and lateral condyles of the tibia. The two condyles form a flat, broad surface for articulation with the medial and lateral condyles of the femur.[17]

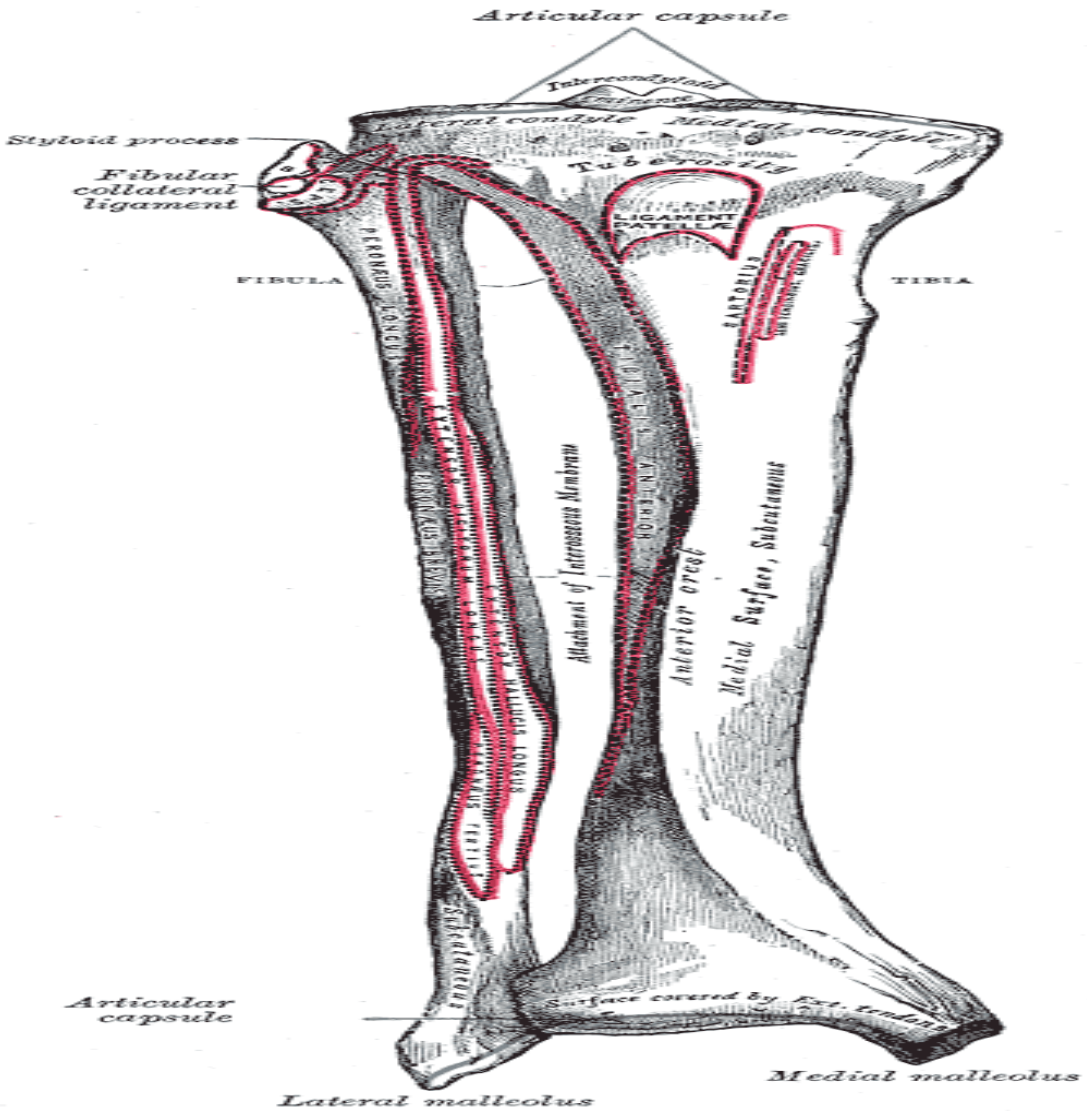
Shaft

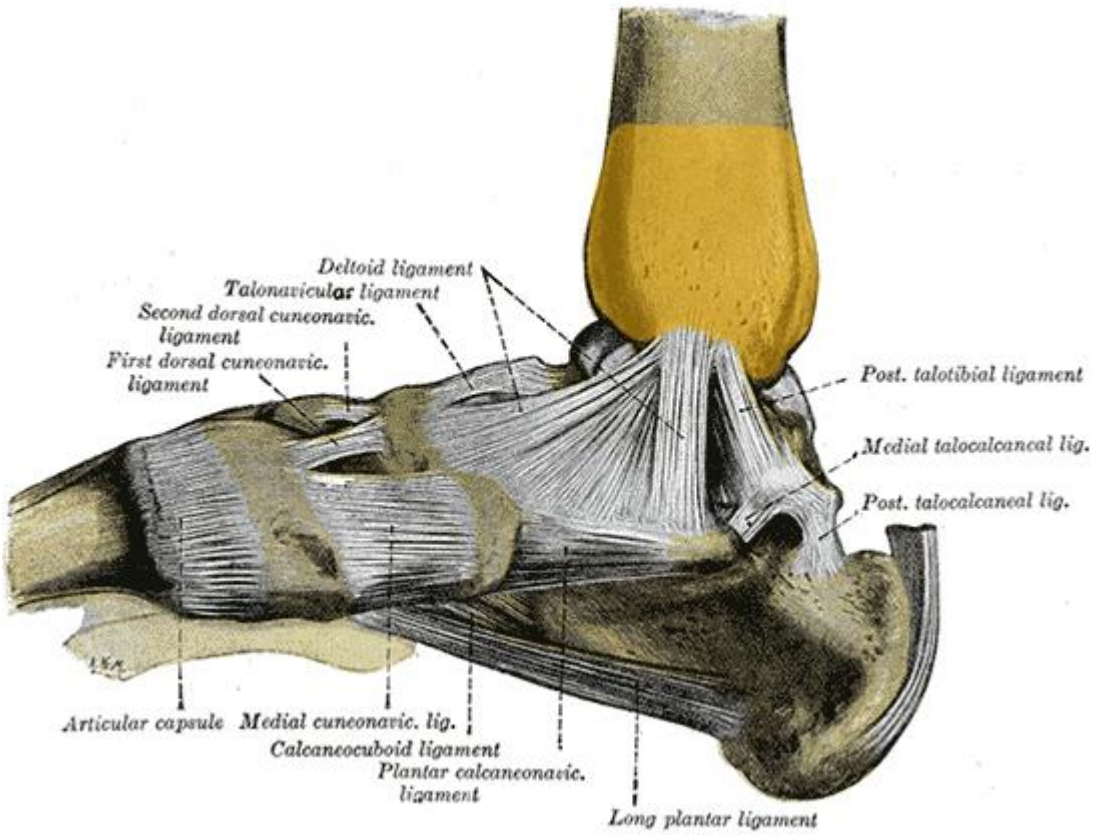
The tibial tuberosity is a palpable bony prominence located on the anterior surface of the proximal shaft of the tibia. On the posterior aspect of the tibia, the soleal line runs diagonally in a distal-to-medial direction across the proximal third of the tibia.[17]

Lateral Distal End

The lateral aspect of the distal tibia forms the fibular notch, creating an articulation between the distal tibia and fibula, the distal tibiofibular joint.[18]

Medial Distal End-Medial Malleolus


Articular capsule
Intercondyloid eminence
Lateral condyle
Medial condyle
Styloid process
Tuberosity
Fibular collateral ligament
LIGAMENT PATELLÆ
FIBULA
TIBIA
SARTORIUS
PERONÆUS LONGUS
TIBIALIS ANTERIOR
Attachment of Interosseous Membrane
Anterior crest
Medial Surface, Subcutaneous
EXTENSOR DIGITORUM LONGUS
PERONÆUS TERTIUS
Articular capsule
Surface covered by Ext. tendons
Medial malleolus
Lateral malleolus



The medial malleolus is the medial surface of the distal portion of the tibia.[19] It is prolonged downward to form a strong pyramidal process and flattened from without, inward.

The medial surface of this process is convex and subcutaneous. The lateral, or articular surface, is smooth and slightly concave, and articulates with the talus. The anterior border is rough, for the attachment of the anterior fibers of the deltoid ligament of the ankle joint. The posterior border presents a broad groove, the malleolar sulcus, directed obliquely downward and medially, and occasionally double; this sulcus contains the tendons of the tibialis posterior and flexor digitorum longus. The summit of the medial malleolus is marked by a rough depression behind, for the attachment of the deltoid ligament.

Blood supply

The Tibia bone is supplied by nutrient artery which is considered as the largest nutrient artery in the human body. Posterior tibial artery mainly enters the bone through its posterior surface and nutrient artery is the branch of this posterior tibial artery.[20]

Muscles

The Semimembranosus muscle originates from the ischial tuberosity and gets insert on the medial condyle of tibia.[20]

The Tibialis anterior muscle gets attach on the shaft of the tibia. It originates from the upper 2/3rd area of lateral surface of the shaft. The primary action of tibialis anterior is dorsiflexion and inversion of the foot.[20]

Sartorius, gracilis and semitendinosus are inserted on the upper part of medial surface of the shaft of tibia.

The soleus muscle originates from the soleal line present on the medial border of tibia and it primarily performs plantar flexion.[20]

The popliteus muscle originates from the lateral epicondyle of femur and gets insert on the triangular area that is present above the soleal line.

Articulations

Proximally, the tibia articulates with the femur to form the tibial-femoral joint of the knee.[4] Distally, the tibia articulates with the talus to form the talocrural joint of the ankle.

Although not functionally a part of the knee, the fibula articulates proximally with the lateral aspect of the tibia, forming the proximal tibiofibular joint. The distal tibiofibular joint is formed by the articulation of the distal tibia and fibula. There is relatively little movement at the proximal and distal tibiofibular joints.[17,18]

Functions

The primary function of the tibia is to accept and distribute weight across the knee and to the ankle. The tibia's articulations with the relatively non-weight bearing fibula serve to maintain alignment of the tibia. Distally, the concave surface formed by the medial malleolus of the tibia and the lateral malleolus of the fibula creates a stable enclosure for the talocrural joint.[18]

Injuries and Conditions

Fractures of the tibial shaft are most likely to occur at the inferior and middle thirds, where the bone is most narrow. Fractures of the tibial plateau are often related to high-impact trauma from motor vehicle collisions or sports.[19]

Osgood-Schlatter Disease is a painful condition in adolescents in which repetitive strain of the quadriceps muscle on the tibial tuberosity leads to ossification and microavulsions.

Suddenly, when a person's foot is stuck in a hole in the ground or while landing from a jump, it causes aggressive abduction and external rotation. Initially, there will be a spiral fracture of lateral malleolus followed by the fracture of medial malleolus. Finally, in the end, there will be cutting off the posterior margin of lower end of tibia. Such type of stages are called as 1st, 2nd and 3rd degrees of Pott's fracture.[20]

Mechanisms of injury, epidemiology and concomitant injuries

Rotational and/or axial stresses are the most common causes of distal tibial fractures. Torsion forces generally result in a spiral fracture, which may be intra- or extra-articular. These are often closed as a consequence of low energy, and the related soft-tissue injuries are generally not serious. Higher energy axial compression forces, on the other hand, cause intra-articular fractures of the distal tibia when the convex talar dome collides with the concave plafond of the distal tibia. The extent of the articular damage is determined by the quantity of energy used and the location of the foot at the moment of contact. The majority of stresses applied to the dorsal (posterior) region of the articular surface during plantarflexion of the foot result in the creation of a rather large posterior fragment. When the foot is dorsiflexed, the talar dome makes contact with the anterior portion of the distal tibial articular surface. When the ankle is in a neutral posture, entire articular surface involvement is commonly visible with a Y-type separation of anterior and posterior pieces, often with central joint impaction (Fig. 3). [21]

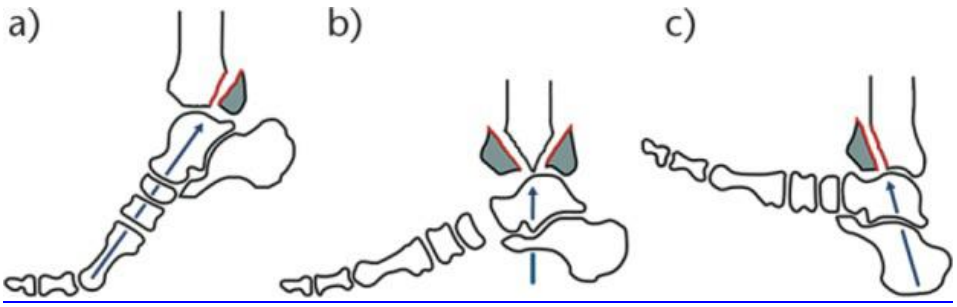


Fig. 3 The role of foot position in the type of distal tibial fracture.

Distal tibial fractures account for 3% to 10% of all tibial fractures and 1% of lower extremity fractures. A fibular fracture, which occurs in more severe traumas, is observed in 70% to 85% of cases. [22-25]

Due to the fact that these fractures are often the consequence of high-energy trauma, up to 50% of patients may have concomitant lower limb injuries, most commonly ipsilateral calcaneal or tibial fractures. Approximately 6% of individuals may have multiple system injuries. [26,27]

Diagnostic testing

Because a considerable proportion of patients may have secondary injuries, a clinical assessment of the patient with a distal tibial fracture should be done according to the Advanced Trauma Life Support protocol.[28]

A complete, systematic clinical evaluation, including peripheral pulses and a meticulous neurological assessment, is part of a clinical examination. It is vital to thoroughly evaluate and record the local soft-tissue state. Although up to 50% of distal tibial fractures are open, closed fractures may still cause severe soft-tissue damage. Local edoema and fracture blisters may develop fast, influencing treatment options and timing. In situations of substantial swelling, the emergence of fracture blisters, or acute pain that does not respond to analgesics, compartment syndrome should always be assumed. [29]

Plain radiographs and CT scans are used in radiological assessment. Plain radiographs are adequate for surgical planning in extra-articular fractures. CT is essential for intra-articular fractures. It has been shown that CT scans gave extra information on the fracture structure in more than 80% of instances, resulting in a change of the previously intended surgical technique in 64% of cases. [30]

Classification

According to Müller, fracture categorization should take into account the severity of the damage, the prognosis, and potential treatment options. The Rüedi and Allgöwer classification and the AO/OTA fracture classification are the most often utilised in publications dealing with intra-articular distal tibial fractures. [31] Extra-articular (type A), partial articular (type B), and full articular (type C) fractures are classified by the AO/OTA. All intra-articular fractures (types B and C) are pilon fractures (Fig. 4).

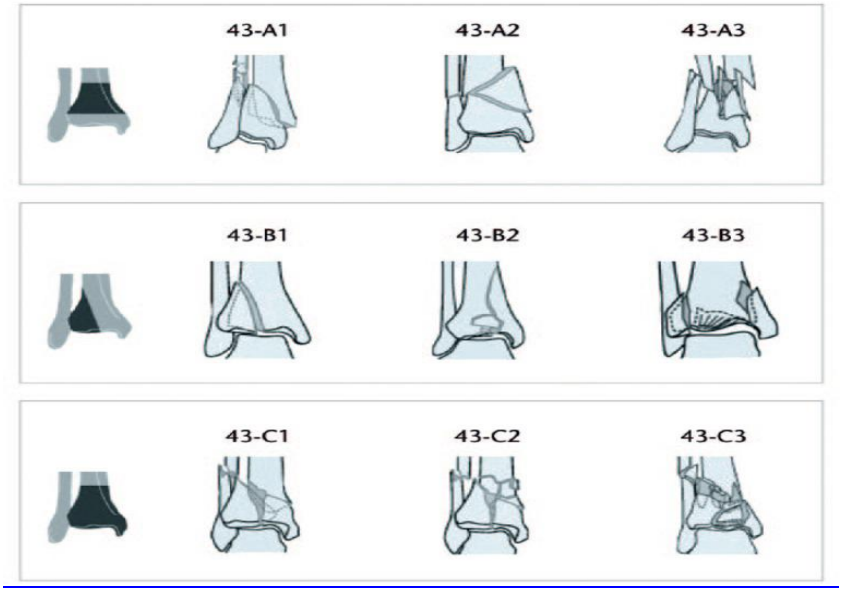


Fig.4 AO/OTA classification of distal tibial fractures. Adapted with kind permission from AO Foundation, Switzerland. 43-A extra-articular fracture. 43-A1 simple; 43-A2 wedge; 43-A3 complex. 43-B partial articular fracture. 43-B1 pure split; 43-B2 split depression; 43-B3 multifragmentary depression. 43-C complete articular fracture. 43-C1 articular simple, metaphyseal simple; 43-C2 articular simple, metaphyseal multifragmentary; 43-C3 articular multifragmentary.

The state of the soft tissues is critical in the treatment of distal tibial fractures. The safety of an early direct approach and open restoration of the articular surface is mostly determined by the state of the local skin and subcutaneous soft tissues. Gustilo and Anderson's categorization of open fractures is the most often utilised. [32] According to Tscherne and Oestern, closed soft-tissue injuries may be categorised. The AO soft-tissue grading system provides for a thorough description of all soft-tissue injuries in open and closed fractures. [32]

Types of external fixation

The form of fixation and amount of stability have a substantial impact on fracture healing physiology. With perfect fracture stability, such as compression plating, the bone will mend from the inside out. Relative fracture stability, such as external fixation, on the other hand, results in subsequent enchondral bone repair. There are also numerous methods for modifying the external fixation design to make the fracture more or less stable.

Factors and Variables Influencing Construct Stiffness and Stability

Changing the pin configuration is one way to improve stability. Placing pins closer to the fracture site, adding additional pins, and increasing pin spread all contribute to the construct's stiffness. However, for final fixation, the pins must be placed out of the way of future surgical approaches. Any increase in pin diameter strengthens the structure to the fourth power while reducing stress at the bone-pin contact. The major effect on the stability of unilateral frames is increased pin diameter. However, bigger pins increase the likelihood of a possible stress riser, which may eventually lead to fracture. A 5 mm pin, for example, is 144% stiffer than a 4 mm pin. [33]

Self-drilling pins, trocar tip pins, and hydroxyapatite-coated pins are examples of pin morphological variants. Another option to improve the construct's strength is to increase the diameter of the rods or fasten it closer to the bone. To increase stability, numerous bars may be added to the same pins. Clamps hold the bars to the pins. Carbon fibre is the most often used material for bars nowadays, and it is 15% stiffer than stainless steel bars. [34]

Types of External Fixators

External fixators are classified into numerous kinds, including uniplanar, multiplanar, unilateral, bilateral, and circular fixators. A multiplanar construct may be created by placing pins in various planes (i.e., perpendicular to each other). Uniplanar fixation devices are quick and simple to use, however they are not as strong as multiplanar fixation devices. When the pins are on both sides of the bone, a bilateral frame is formed, which may give extra stability. Circular fixators have gained popularity in limb lengthening treatments, but they are particularly successful at enabling the patient to bear weight and keep some joint mobility during treatment. They are more difficult to apply because they need smaller gauge pins and a greater number of them to disperse the weight. [35]

There are several methods to modify and improve the external fixation design. To make matters even more complicated, hybrid frames are a mix of any of the previously stated constructions. The surgeon must provide a degree of stability that allows for optimum healing. It's also important to grasp fundamental fracture principles, since stiffer isn't necessarily better when it comes to external fixing.

Treatment

The treatment idea for this kind of fracture includes soft tissue management, joint surface reconstruction, and limb alignment restoration. Nonsurgical and surgical treatment options are available for tibial plafond fractures. Internal fixation, external fixation with or without limited internal fixation, and primary arthrodesis are surgical alternatives. The treatment decision is guided by the state of the soft tissues. The nonsurgical treatment of tibial pilon fractures, which relied on prolonged transcalcaneal traction or casts, has been overtaken by contemporary surgical procedures and is now reserved for only the most severe patients. [36] Nonsurgical therapy is limited for plafond fractures with minor displacement and limb alignment that may be maintained with a cast. For at least 4-6 weeks, weight bearing is banned. The outlook is favourable.

As with all articular fractures, surgical therapy with open reduction and internal fixation is the most dependable technique to achieve anatomic reduction of the articular surface. This treatment strategy, however, should be carefully weighed against not only the state of the soft tissues (the vascularity may be altered by an early surgical approach), but also the comminution and quantity of pieces. The initial step is to repair the fibula in order to restore the right length of the tibia and to permit three-dimensional alignment and fracture reduction. For the treatment of these fractures, many surgical techniques to the tibia have been documented. [37]

Whatever surgical procedure is selected, the surgical approach should be focused on the bigger bone fragment and care should be made not to traumatise the skin using aggressive surgical technique. An arthrotomy is required for precise reduction of articular fragments. At this point, the essential principles presented by Ruedi and Allgöwer remain relevant, with the goal of

maintaining an articular surface incongruity of no more than 2 mm. [38] The AO suggests using a plate for interim external stabilising of the epiphyseal region before advancing to the meta-epiphyseal area for final repair and stabilisation (LCP). Other schools of thought advocate using a hard anatomical plate that is anchored proximally to force the reconstruction of the distal anatomy onto the plate.

External fixation as a final therapy has gained popularity in recent years, owing to the advantages it gives in terms of minimum interference with soft tissue. The concept of external fixator therapy is ligamentotaxis; however, whereas most fixators are designed to produce a tibiotalar-calcaneal bridge, circular fixators allow for a tibial-only assembly. Although this is not always practicable, it may allow for early ankle mobilisation and, depending on the size and orientation of the wires, a juxta-epiphyseal assembly and partial control over the comminution of the pieces that may be formed under arthroscopy supervision. [39] In any instance, the external fixator assembly should not risk the accomplishment of an eventual covering flap and, as with internal fixation, should be preceded by fibular synthesis, if required, to restore the right length. Several writers have also combined this form of treatment with percutaneous osteosynthesis of epiphyseal fragments utilising free screws or wires under C-arm control. For these fractures, articulated external fixators, minimally invasive percutaneous plate osteosynthesis, or a mix of internal and external fixing may be used. Arthrodesis is currently exclusively used for severe articular comminution that cannot be repaired otherwise. [40]

Ovadia DN et al (1986)[41] Eighty patients underwent open reduction and rigid internal fixation whereas others underwent other procedures like closed reduction and cast, calcaneus pins and plaster, fibular stabilization and cast, limited internal fixation and external fixation. They had

34 fractures equivalent to Ruedi 14 and Allgower Type III and good to excellent results were achieved only in 47% of the patients.

Bonar SK et al (1993)[42] evaluated 48 patients using hinged trans-articular external fixator, they reported that postoperative complications were minimal with no cases of superficial or deep wound infection or dehiscence. They obtained 70% excellent to good results. The main limitation of this technique appeared to be in obtaining an excellent articular reduction. Although unknown, this limitation may have had significant effect on thelong-term clinical outcome.

Tornetta PI et al (1993)[43] using the technique of hybrid external fixator, seventeen patients with distal tibial fractures gave 69% good results and major complications were avoided. Without crossing the ankle joint, tensioned 2mm wires were placed in the distal tibia with half pins more proximally in the tibia. Patients with Ruediand Allgower Type II and III fractures were treated with skeletal traction, and surgery was performed when oedema resolution had occurred.

Saleh M et al (1993)[44] evaluated the patients with severe intra-articular fractures of distal tibia were treated with internal fixation. An articulated external fixator maintained tibial length. Fibula fracture was fixed internally. Nearly 67% of the patients had good to excellent results. This technique was less invasive than open procedures that required the use of a tibial plate especially in open fractures.

Helfet DL et al (1994)[45] was follow up evaluations of 34 distal tibial fractures showed that results of operative treatment are dependent on the severity of the 15 initial trauma, the quality and stability of the reduction. The mechanism of injury, soft tissue status, the degree of comminution and articular damage affect the long term outcome. 65.4% of Type II fractures had excellent results, 11.5% adequate and 23.1% had poor results. In Type III fractures, only 20% had excellent, 12.5% adequate and 37.5% poor results.

Barbieri R et al (1996)[46] evaluated 36 patients using the Hybrid External Fixator achieved 67% acceptable injuries in the high-energy fractures treated. There were three cases of osteomyelites, one skin slough and five pin tract infections.

Gaudinez RF et al (1996)[47] open reduction and internal fixation was observed in fourteen patients treated with Hybrid external fixators. They had 64% acceptable results and mean union time was 13 weeks. They concluded that a Hybrid External Fixator is useful, particularly in comminuted fractures where anatomic reduction cannot be expected despite open reduction.

Wyrsch B et al (1996)[48] reported disastrous results when inadequate and unstable fixation was used to treat the distal tibial fractures. They had 36% rate of skin sloughing and a 55% infection rate. A randomized prospective study involving two groups of patients, one who underwent open reduction and internal fixation and the other group who underwent external fixation, showed no significant difference. However, because of the relatively greater number of complications in the internal fixation group, with no significant difference in outcome, they concluded that limited internal fixation combined with use of external fixator was an equally effective and safer alternative.

Anglen JO et al (1999)[49] studied on 63 patients treated with Hybrid External Fixator and internal fixation, the authors noted that the patients 18 treated with Hybrid External Fixator had lower clinical scores, a higher rate of complications, more nonunions, malunions, slower return to function and more infections. They concluded hybrid fixation did not seem to rectify the problems inherent to severely comminuted distal tibia fractures.

Pugh K.J. et al (1999)[50] In a retrospective review of 60 patients, to evaluate whether treatment with open reduction with internal fixation was better than external fixation methods in achieving fracture union, there were no statistically significant differences in complication rates. High degree of malunions occurred with fractures treated with external fixators. They concluded that external fixation addresses soft tissue compromise associated with distal tibial fractures, but malunionis a recognized complication.

French B et al (2000)[51] in a series of patients treated with Hybrid External Fixator the authors concluded that Hybrid External Fixator reduces the number of iatrogenic complications associated with open reductions and internal fixation. The Hybrid External Fixator had proved to be a safe, reproducible and effective treatment modality in fractures of distal tibia.

Yang M et al (2003)[52] determined the effect of different constructs of Hybrid External Fixator on the mechanical environment of the fracture site, the authors opined that the bar ring hybrid fixator that simply connected a unilateral fixator to a wire or ring assembly was very flexible. Reinforcing the bar ring hybrid fixator with diagonally placed struts eliminated the deforming forces.

Piper KJ et al (2005)[53] In a review of 24 patients, Anglen concluded that hybrid fixators can be used for the treatment of distal tibia fractures as they provide rigid fixations with minimal soft tissue injury.

Patil DG et al. (2015)54 evaluated the outcomes of tibial plateau fracture treatment with conventional nonlocking buttress plates (BP group) versus locking compression plates (CP group) (LCPs). The schatzker Type II fracture was discovered to be the most prevalent fracture type, with 13 individuals. In 24 cases, just lateral plating was performed, while dual plating was performed in 6 individuals. Corticocancellous bone grafts were utilised in 8 individuals. Complications such as superficial skin necrosis (two instances), infection (two cases), and varus collapse (three cases) arose during the follow-up period. Sixty percent of fractures in the

LCP group, 66.6% in the buttress group, clinically unified in 7-9 weeks, and 73.3% in the LCP group and 80% in the buttress group radiologically united in 12-15 weeks. They came to the conclusion that, because to its high cost, LP group should only be employed when it is more beneficial than ordinary plate.

Kleven V B et al (2016)[55] investigated the percentage of complications and functional outcome in patients with distal tibia fractures after ORIF with low-profile locking plates. 70 patients with 71 distal tibia fractures treated with a low-profile locking plate were included in the study. There were 32 43A fractures, 5 43B fractures, 34 43C fractures, 12 open fractures, and 10 high-energy fractures. During the follow-up period, 49 patients (69%) suffered problems, 34 of which were mild and 15 of which were significant. They hypothesised that treating distal tibia fractures with low-profile locking plates would result in a larger percentage of complications and a worse functional outcome than had previously been documented.

Jan I et al. (2016)[56] compare the impact of external fixation and LCP methods on bone union time, infection, postoperative complications, operational time, bleeding, and cost effectiveness in the therapy of extra-articular proximal third tibial fractures. The 40 patients were separated into two groups according on their surgical treatment: the observation group, which included 20 patients treated with external fixation, and the control group, which included 20 patients treated with open reduction internal fixation with locking compression plate. They discovered that at one week post-op, radiological examination revealed that 18 patients (93%) in the LCP group had anatomical reduction compared to 16 patients (80%) in the external fixation group. The mean Rasmussen knee score in the EF group was 25 and 24.5 in the LCP group. Both groups had a mean weight bearing time of 13 weeks after surgery. They determined that both treatment techniques provide positive effects. External fixation treatment is less invasive, requires less soft tissue dissection, and has a lower risk of infection.

Zhang JW et al (2016)[57] evaluated the feasibility and efficiency of one-stage external fixation by using locking plate in distal tibial fractures. 28 patients with distal tibial fractures were included and underwent one-stage external fixation by using locking plate. they were found that the mean time to fracture healing were 14.6 ± 2.67, 17.5 ± 3.66, and 18.4 ± 3.37 weeks in type A1, A2, and A3 fractures respectively. By the end of the follow-ups, the mean AOFAS score were 96.11 ± 2.32, 92.67 ± 1.80 and 92.00 ± 2.06 in type A1, A2, and A3 fractures respectively. they concluded that the distal tibial fracture was the ideal indication for external fixation using locking plate.

Luo P et al (2017)[58] conducted a meta-analysis of the biomechanics, functional results, and consequences of using a locked plate as an external fixator to treat tibial fractures. They go through electronic media for this evaluation. Because of the variety of biomechanical research, they determined that exterior locked plates had lower structural stiffness than internal locked plates. Clinical investigations have shown that using locked plating as an external fixator to treat tibial fractures is a safe and effective method.

Sharma S.C. et al. (2019)[59] compare the treatment of distal tibial fractures using a distal tibial locking plate against an interlocking nail. Closed reduction and fixation with IMIL Nailing was used on 30 patients (Group A), while Distal Tibial Locking Plate with MIPO Technique was used on another 30 patients (Group B). They discovered no significant difference in fracture healing time or ambulation time. Group A had good to excellent performance of 60%, while Group B achieved 73.3%. Group A had 13.3% of the worst outcomes, while Group B had 6.7%. Group A had a greater overall complication rate. Due to post operational findings of medullary canal being smaller than 8 mm in one instance and curved in another, IMIL Nailing had to be abandoned in two cases (6.7%) and DTLCP turned on. IMIL Group A also had two (6.7%) bent nails, two (6.7%) broken nails, and three (10%) bent/broken locking bolts. In Group B, no such implant-related problems were reported. Before considering IMIL Nailing, they decided that it

is a technically challenging surgery that requires a full pre-operative workup and a trained experienced surgeon with all sizes of nails, reamers, and other choices available.

Kamble P et al (2020)[60] assessed the outcomes of MIPO in terms of fracture healing and complication rates. A group of forty patients with preoperative X-rays showing a distal tibia fracture were treated with minimally invasive plate osteosynthesis utilising pre-contoured locking plates. Teeny and Wiss clinical grading method for ankle joints was used to assess functional scores. Thirty-two patients had a 'Good' or 'Excellent' result. At the time of the follow-up, one patient was diagnosed with a soft tissue problem and delayed union, and three patients were diagnosed with malunion without severe functional loss. They came to the conclusion that minimally invasive plate osteosynthesis using pre-contoured locking plates had a high union rate and excellent functional results.

Thadiparthi VK et al. (2021)61 compared the clinical and functional outcomes of IMN and MIPO in the treatment of extra-articular distal tibial fractures. This research comprised 56 patients with extra-articular distal tibia fractures (OA types 43A1, A2, and A3). One group received an intramedullary nail, while the other received a minimally invasive locking compression plate. The data were analysed using the Olerud-Molander score, which indicated that eight patients had outstanding outcomes, 45 had acceptable outcomes, and two had fair outcomes. One patient in the plating group had a bad outcome. They found that intramedullary interlocking nailing is a highly successful treatment option for closed extra-articular distal tibial fractures, however it is technically hard. When the local soft tissue state is excellent, plating may provide adequate outcomes.

Solanki R et al (2021)[62] compare, analyse, and individualise the optimum treatment strategy for distal tibial fractures. The mean AOFAS score for 30 patients treated with Intra-Medullary Nail was 75.2, whereas the mean AOFAS score for patients treated with External Fixator and MIPO was 71.5 and 87.1, respectively. They examined overall outcomes such as functional recovery, radiographic evaluation for malalignment, and comorbidities associated with various treatment techniques for distal tibial fractures.

Ladani HG et al (2021)[63] used the MIPO approach to study distal tibial extra-articular fractures treated with locking compression plates. Twenty patients with closed extra-articular distal tibial fractures were treated with anatomical LCP put on the antero-medial surface of the lower end tibia using the MIPO method. It was discovered that 15 individuals had AO/OTA type 43 A1 fractures. Four points were 43 A2 and one point was 43 A3 type fracture. They found that MIPO with LCP is a reliable and successful way of treating distal tibial extraarticular fractures, conserving the majority of osseous vascularity and fracture haematoma and so giving a more biological healing.

Motawea BA et al (2021)64 compared between external locked plate and conventional open reduction and internal fixation on distal tibial fractures. A total of 56 patients with closed distal tibial fractures were divided into two equal groups at random. Patients in Group A had standard open reduction and internal fixation, while patients in Group B received external locked plate fixation (supracutaneous plate). They discovered that patients in group B had much better clinical and radiological outcomes than those in group A. The union in group B was faster (12.96±2.74 weeks) than in group A (18.68±12.12 weeks), and the difference was statistically significant. In contrast to group A, the risk of complications was much lower in group B, with just three patients having superficial self-limiting infection and 11 patients having deep infection and skin dehiscence with plate exposure. None of the patients in Group B had implant failure, but seven instances in Group A. They found that external locking plate treatment of

closed distal tibial fractures might result in a better functional outcome than traditional open reduction and internal fixation, while avoiding skin problems associated with conventional plating.

Sivakumar A et al.(2021)[65] used MIPPO to assess the surgical treatment of distal tibial fractures treated by internal fixation with locking compression plates and screws. There were 15 extra-articular fractures and 6 intra-articular fractures among the 21 patients. 85% of the fractures healed in 16 weeks or less, with an average of 15.7 weeks. They observed delayed unions in three individuals, probably related to intraoperative traction and comminution. Nineteen patients (90%) achieved good to outstanding outcomes at 22 weeks with fracture union based on Tenny and Weiss rating criteria for the ankle. They found that employing a locking compression plate for intra and extra-articular distal tibia fractures through a minimally invasive approach in conjunction with fibular fixation is safe and effective.

Suryawanshi R.I. et al (2022)[66] sought to examine the prognosis of distal tibial intraarticular fractures treated with an external fixator. This research involved 30 participants. The clinical outcome of the research includes a mean score of 81.5 out of a possible 100. The first need was ankle arthrodesis, and this patient received 9 points for reduction quality. The clinical findings revealed that the patient had A5 valgus deformity, which was also associated with diabetes. The findings focused on the strategy of external therapy were determined to be satisfactory and were applied to additional clinical trials of patients. According to the findings of the research, external fixator therapy for communited intraarticular fractures of the distal tibia is advantageous and has a favourable influence on the process of providing the necessary support to the patients.

MATERIALS AND METHOD

Materials and method

Study Period:

The study would be conducted from November 2020 to October 2022.

Study Setting:

The study would be carried out among patients (skeletally mature individuals aged 25 to 50 year old) reporting to Orthopedics OPD/Emergency with Distal Tibial intra-articular fracture at Santosh medical College, Ghaziabad (UP).

Study Area:

Department of Orthopedics, Santosh Medical College, Ghaziabad (UP)

SELECTION OF CASES

Inclusion Criteria:

1. Patients reporting to Santosh Medical college with Distal Tibial Intra-articular fractures
2. Skeletally mature patients aged 25 to 50 years.
3. Patients wasing to provide “signed and informed consent”
4. Closed fracture patients

Exclusion Criteria:

Cases with the following findings were excluded:

1. All patients below 25 years and above 50 years
2. Polytrauma patients
3. Patients who are unfit for surgery

4. Patients with degenerative bone diseases
5. Patients with neurological conditions
6. Pregnant patients, or immuno-compromised patients
7. Patients refusing to give informed consent

Study Population (Sample size):

A sample of minimum 60 individuals was calculated (30 per study group) keeping the available time duration of one year for cases reporting to Santosh Medical College, Ghaziabad (UP). This calculation was supported with the findings from a previous study by Viberg B et al (2016) (27), which showed prevalence of post-intervention serious complications (amputation) as 2% in their study. According to those findings, a minimum sample size of 28 individuals was calculated (using Open Epi v3.0) (Figure 1).

However, to compensate for the patients lost to follow up or unresponsive cases, nearly 5% sample was added, rounding off the total sample size to a minimum of 30 per group (total sample size 60). Sample selection was done using convenience sampling method (first come first serve basis) for the study.

Sample Size for Frequency in a Population

Population size(for finite population correction factor or fpc)(*N*):	1000000
Hypothesized % frequency of outcome factor in the population (*p*):	1.8%+/-5
Confidence limits as % of 100(absolute +/- %)(*d*):	5%
Design effect (for cluster surveys-*DEFF*):	1

Sample Size(*n*) for Various Confidence Levels

ConfidenceLevel(%)	Sample Size
95%	28
80%	12
90%	20
97%	34
99%	47
99.9%	77
99.99%	108

Equation

Sample size $n = [DEFF*Np(1-p)]/ [(d^2/Z^2_{1-\alpha/2}*(N-1)+p*(1-p)]$

Results from OpenEpi, Version 3, open source calculator--SSPropor
Print from the browser with ctrl-P
or select text to copy and paste to other programs.

Figure 1: (Sample size calculation using Open Epi v3.0)

Ethical Approval:

Ethical Approval would be taken from the Institutional Ethical Committee after explaining the Aim and Objectives of the Study.

Informed Consent:

A written Informed Consent would be obtained from each patient before clinical examination as well as data collection. The involvement of the subject was voluntary and deliberate.

Method of Data Collection:

A total of 60 patients reporting with distal tibial intra-articular fracture aged 25 to 50 years reporting to Santosh Medical College, Ghaziabad (UP) and not currently undergoing any other treatment were included in the study, and were further examined.

The details of patient's particulars, as well as socio-demographic details were recorded by the investigator. The details of the complaint were recorded in a pre-fabricated case history format. The case history format included chief complaint, and details of duration of illness, along with medical history. A written questionnaire was filled out prior to sampling, focusing on patient.

The study participants were subdivided into two groups: External Fixation group (Group A) and Locking Plate group (Group B). Intervention modality was similar across both groups except for the technique used. The surgery was not performed until the swollen soft tissue relieved. The skeletal traction and administration of medicine were prescribed to alleviate the swelling. For the open fractures, the fixation of fracture was achieved after debridement in an emergency setting. The associated distal fibular fractures were internally fixed to correct the length, and provide lateral stability.

Group A (External Fixation group):

Surgery is usually performed with the patient under general anaesthesia. The patient lies supine on the operative table with trans-calcaneal traction. The amount of reduction achieved by ligamentotaxis is checked using by intensification. If internal fixation is required for the lateral malleolus, this procedure is performed first to restore fibular length. Great care must be taken in accurate reduction of the "Tillaux" fragment; reduction can be obtained with minimally invasive manoeuvres performed with a smooth 3 mm wire used as a joystick and stabilised with 1.8–2.0 mm wire or with a cannulated screw.

When distal migration of fragments is noted, these fragments can be replaced in the correct position (using fluoroscopic check) with the aid of a clamp inserted proximally through a minimal skin incision. An olive wire can also be introduced through the tibial malleolus, first to reduce the fracture (usually tilted in varus and anterior) and then to compress the fracture site.

Alternatively, internal osteosynthesis of the medial malleolus, if feasible, is performed. Once reduction of the anterior fragments is accomplished, displacement of the posterior malleolus is achieved with dorsiflexion of the foot. The reduction is maintained with a guide wire for subsequent insertion of a cannulated screw. After restoration of articular congruity, a 1.8 mm Ilizarov wire (2.0 mm if SRF) is passed parallel to the articular surface in the AP view on X-ray, approximately 2 cm from the joint line in the tibial epiphysis.

The circular frame is then assembled on this wire and the injured limb. The use of carbon fibre rings facilitates radiographic assessments. The alignment is continually checked by image intensification in both planes. Additional smooth or olive wires are inserted in safe corridors to improve the alignment and increase stability.

On the distal tibial ring at least three wires are required. On the proximal block, half pins are inserted in combination with wires. The wires are fixed to the rings of the fixator and tensioned. When necessary the foot is incorporated by wires and screws inserted in the calcaneus and fixed to a half ring connected to the tibial external fixator. The foot is fixed in neutral position to avoid supination and equines position.

Following placement and tensioning of these main wires, the remaining displaced fragments can be gently reduced by inserting additional wires in a manner that allows reduction forces to be applied through the displaced fragment. In multi-fragmental fractures great care must be taken to avoid reducing a fragment with a wire that ‘locks’ another fragment in a non-reduced position.

Group B (Locking Plate group):

For the tibial fractures with spiral and oblique morphology, an incision with a length of 3-4 cm was at the anterolateral aspect of tibia to expose and clean the gap between the fracture end. Using manual traction at the ankle or through a single Steinmann pin inserted into the calcaneus, the fracture was anatomically reduced.

A femoral LISS plate (9e11 holes) (Synthes, Oberdorf, Switzerland) was placed over the anteromedial aspect of tibia. The contralateral femoral LISS plate was used for fixation. i.e., a right femoral LISS plate was used to fix a left distal tibial fracture, and a left femoral LISS plate was used to fix a right distal tibial fracture. This peculiarity was incorporated into our surgical technique because we found that the contour of contralateral femoral LISS plate was matched to the anteromedial aspect of the lower leg.

The broad end of the plate was placed close to ankle joint, which can provide more screws to stabilize the short distal segment. The plate was placed as close to the skin as possible to increase the stability of fixation. The folded gauge (1-2 cm in thickness) was used to keep the plate apart from the skin, preventing abrasion or shear stress between the plate and skin.

Successive holes were drilled over locking drill-guides through incisions where the overlying soft tissue is intact, and at this point, depth was confirmed by using a depth gauge. The locking screws of corresponding length were inserted. All screws achieved bicortical purchase. In both proximal and distal fragments, 4 to 5 bicortical locking screws were inserted respectively.

The position and orientation of screws were checked with X-ray. The skin was sutured and a drainage tube was placed which was pull out 24 h later. For comminuted distal tibial fractures, we did not perform open reduction. Under live C-arm X-ray, the reduction of length and alignment was achieved by manual traction and percutaneous manipulation using Schanz pins.

The patients were allowed to walk with partial weight bearing from post-operative Day 2. The pin sites were cleaned twice a day using a Betadine solution. Patients were examined in the outpatient clinics every 4 weeks for radiographical and functional evaluation. Once cortical bridging on biplanar radiographs was observed, the patients were allowed to walk with full weight bearing for one month before the plate was removed in the outpatient setting

PRE OP

POST OP

KATZ Activity of Daily Living Score:

Evaluation of patient's ADL was carried out at all the phases using validated Katz ADL questionnaire. This questionnaire was chosen because of its widespread use in the evaluation of ADL status. Data collection for the pre-fracture and ward admission phases were performed when the subjects were in the ward. All data was based on self-report by interviewing the subject, while the researcher would fill out the questionnaire.

Patient Name:_____ **Date:**_____
Patient ID #_____

Katz Index of Independence in Activities of Daily Living

Activities Points (1 or 0)	**Independence** (1 Point) **NO** supervision, direction or personal assistance.	**Dependence** (0 Points) **WITH** supervision, direction, personal assistance or total care.
BATHING Points: _____	**(1 POINT)** Bathes self completely or needs help in bathing only a single part of the body such as the back, genital area or disabled extremity.	**(0 POINTS)** Need help with bathing more than one part of the body, getting in or out of the tub or shower. Requires total bathing
DRESSING Points: _____	**(1 POINT)** Get clothes from closets and drawers and puts on clothes and outer garments complete with fasteners. May have help tying shoes.	**(0 POINTS)** Needs help with dressing self or needs to be completely dressed.
TOILETING Points: _____	**(1 POINT)** Goes to toilet, gets on and off, arranges clothes, cleans genital area without help.	**(0 POINTS)** Needs help transferring to the toilet, cleaning self or uses bedpan or commode.
TRANSFERRING Points: _____	**(1 POINT)** Moves in and out of bed or chair unassisted. Mechanical transfer aids are acceptable	**(0 POINTS)** Needs help in moving from bed to chair or requires a complete transfer.
CONTINENCE Points: _____	**(1 POINT)** Exercises complete self control over urination and defecation.	**(0 POINTS)** Is partially or totally incontinent of bowel or bladder
FEEDING Points: _____	**(1 POINT)** Gets food from plate into mouth without help. Preparation of food may be done by another person.	**(0 POINTS)** Needs partial or total help with feeding or requires parenteral feeding.

TOTAL POINTS: _____ **SCORING:** 6 = High (*patient independent*) 0 = Low (*patient very dependent*

Figure 2 (KATZ Activity of Daily Living Score)

Statistical analysis

After the data had been entered into the spreadsheet using Microsoft excel, the statistical analysis was carried out using the statistical programme SPSS version 25.0. The information about the numerical variables was provided as the mean and standard deviation, whilst the information regarding the categorical variables was presented as the frequency and percentage of each category.

The student t-test was used to compare the mean values of the two groups, and the chi-square test was used to assess the frequency differences that existed between the two groups. Both of these tests were carried out. It was deemed as statistically significant if the p-value was less than 0.05, which is the threshold at which it was considered to be significant.

RESULTS

RESULTS

Table 1: Distribution of study population according to

	Age		
Groups	Mean	Std. Deviation	p-value
External fixator	45.13	3.93	0.202
Plating	46.40	3.67	

There was no significant difference in mean age between External fixator and Plating groups.

Table 2: Distribution of study population according to

	Groups		Total
	External fixator	Plating	
Female	8	6	14
	26.7%	20.0%	23.3%
Male	22	24	46
	73.3%	80.0%	76.7%
	30	30	60
	100.0%	100.0%	100.0%
χ^2 value = 0.373, p-value = 0.542			

There was no significant difference in the distribution of males and females between External fixator and Plating groups. There were 76.7% males and 23.3% females.

Table 3: Distribution of study population according to

	Surgical time		
Groups	Mean	Std. Deviation	p-value
External fixator	83.43	50.63	0.123
Plating	91.40	4.69	

There was no significant difference in mean Surgical time between External fixator and Plating groups.

Table 4: Distribution of study population according to

Side affected	Groups		Total
	External fixator	Plating	
Left	8	6	14
	26.7%	20.0%	23.3%
Right	22	24	46
	73.3%	80.0%	76.7%
	30	30	60
	100.0%	100.0%	100.0%
χ^2 value = 0.373, p-value = 0.542			

There was no significant difference in the distribution of side affected between External fixator and Plating groups. The right side was affected in 76.7% cases and left side in 23.3% cases.

Table 5: Distribution of study population according to

Mode of Injury	Groups		Total
	External fixator	Plating	
Fall	5	7	12
	16.7%	23.3%	20.0%
RTA	25	23	48
	83.3%	76.7%	80.0%
	30	30	60
	100.0%	100.0%	100.0%
χ^2 value = 0.373, p-value = 0.542			

There was no significant difference in the distribution of side affected between External fixator and Plating groups. The mode of injury was fall among 20.0% and RTA among 80.0% cases.

Table 6: Distribution of study population according to

	KATZ Activity of Daily Living Score		
Groups	Mean	Std. Deviation	p-value
External fixator	4.97	0.76	0.043*
Plating	5.43	0.63	

The mean KATZ Activity of Daily Living Score was significantly more among Plating group compared to External fixator group.

Table 7: Distribution of study population according to

Complications	Groups		Total
	External fixator	Plating	
Nil	26	27	53
	86.7%	90.0%	88.3%
Superficial infection healed	4	3	7
	13.3%	10.0%	11.7%
	30	30	60
	100.0%	100.0%	100.0%
χ^2 value = 0.891, p-value = 0.478			

There was no significant difference in the distribution of Complications between External fixator and Plating groups.

Table 8: Distribution of study population according to

KATZ Activity of Daily Living Score	Groups		Total
	External fixator	Plating	
4	6	2	8
	20.0%	6.7%	13.3%
5	12	13	25
	40.0%	43.3%	41.7%
6	12	15	27
	40.0%	50.0%	45.0%
	30	30	60
	100.0%	100.0%	100.0%
χ^2 value = 2.373, p-value = 0.305			

KATZ Activity of Daily Living Score 6 was significantly more among Plating group compared to External fixator group.

DISCUSSION

The treatment of intraarticular fractures of the distal tibia may have a considerable effect on the individual's ability to carry out daily activities because of this. The research has uncovered a number of concerns and potential courses of therapy in order to determine the effect of the external fixator. Open reduction and internal fixation (ORIF) has resulted in varying outcomes for high energy distal tibia fractures, according to Beytemür et al.[67]

The demand for external fixator therapy is being influenced by the poor outcomes of internal treatment as well as the patient's lack of happiness with the treatment overall.[68] According to the study, the fact that the patient developed a stiff ankle along with equines of the foot as a result of the stoppage of their physiotherapy treatment contributed to the upkeep of the treatment's high standards. In two of the patients, an infection at one of the three pin sites from the distal tibia ring was discovered, and these pins were subsequently replaced with a wire and a screw. In addition to this, the joint surface, which led to advanced dislocation and healing, as well as selecting the correct posture for enhancing the stability, was affected.[66]

Direct vision and manipulation of the fracture fragments, stable stiff fixation, and the potential of immediate postoperative mobility are some of the benefits that come with open reduction and internal fixation. Fixed-angle plate designs prevent screws from becoming loose in the distal pieces as a result of a "toggling effect," and as a result, they lessen the risk of subsequent displacement. Especially in osteoporotic bone, the subchondral implantation of smooth pegs may be helpful in buttressing tiny articular fragments and effectively controlling shortening and angular displacement.[69]

Age

It was found in our study that there was no significant difference in mean age between External fixator and Plating groups. *Anant S et al*.[70] reported that there were people ranging in age from 19 to 64 years old. The majority of patients, or 43.33 percent, were between the ages of 20 and 30 years old, while the average age of a patient was 36.1 years. *Donimath et al*.[71] found that the mean age of patients was 40.3 years. *Gill et al*.[72] found that among external fixation group, 51.8% of patients were between the ages of 41 and 50, whereas in the ORIF group, 30.3% of patients were in this age range. However, 30% of patients in the Ext. fix group and 24.24% of patients in the ORIF group were younger than 30 years old. 39.39% of patients in the ORIF group were between the ages of 30 and 40.

Gender

In present study, there was no significant difference in the distribution of males and females between External fixator and Plating groups. There were 76.7% males and 23.3% females. *Anant S et al*.[70] reported that there was male predominance with male to female ratio being 23:7. *Donimath et al*.[71] found that Fourteen patients were men and four were women. *Gill et al*.[72] found that majority of the patients in both Ext. fix group (85.2%) and ORIF group (72.7%) were males.

Surgical time

The present research showed that there was no significant difference in mean Surgical time between External fixator and Plating groups. It was stated by *Ahmed et al*.[73] that the operative time did not statistically differ between the two groups, but it was relatively longer in the MIPO group. This can be attributed to the longer time of fluoroscopy usage, which was significantly longer than the ORIF group. However, the operative time in the MIPO group was

comparable to the ORIF group. It was reported by *Guo et al*., *Wang Cheng et al*., and *Jun Shen et al*. that the mean operating time for the MIPO method was 97.9 minutes, 113.33 minutes, and 56.0 minutes, respectively.[74-76]

Side affected

In current study, there was no significant difference in the distribution of side affected between External fixator and Plating groups. The right side was affected in 76.7% cases and left side in 23.3% cases. *Anant S et al*.[70] reported that discovered that the injuries experienced to both sides were about similar, with the right side having a little larger percentage of injuries (53.3%), compared to the left hand's lower percentage (46.7%). The same results were also reported in a research that was carried out by Wei and colleagues, in which there were a total of 12 injuries to the right wrist and 10 injuries to the left wrist.[77] *Donimath et al*.[71] found that Left side was affected in 11 patients (61.1%) and right side was affected in 07 patients (38.9%). *Gill et al*.[72] found that 44.4% of Ext. fix group and 48.5% of ORIF group had left‑sided fracture. More than half (55.6%) of Ext. fix group and (51.5%) ORIF group had right‑sided fracture.

Mode of injury

There was no significant difference in the distribution of mode of injury between External fixator and Plating groups. The mode of injury was fall among 20.0% and RTA among 80.0% cases. *Anant S et al*.[70] reported that 24 patients had road traffic accident, 4 had fall on the floor and one each had fall of heavy object and assault. *Jan et al*.[56] stated that Mechanism of injury included athletic injuries 30%, motor-vehicle accidents 40%, domestic injuries 18% and other causes 12%. *Donimath et al*.[71] found that the most common mode of injury was road traffic accidents in 16 patients (88.89%), fall in 1 patients (5.56%) and assault in one patient (5.56%).

Gill et al.[72] found that 42.4% of ORIF group patient sustained injury through fall on outstretched hand. More than half (63%) of Ext. fix group and (57.6%) ORIF group patients sustained injury through road traffic accident.

KATZ Activity of Daily Living Score

In our research, the mean KATZ Activity of Daily Living Score was significantly more among Plating group compared to External fixator group. KATZ Activity of Daily Living Score 6 was significantly more among Plating group compared to External fixator group. *Shukla et al*.[78] showed that those who were treated with external fixation had a success rate of 85.5%, whereas patients who were treated with volar plating had a success rate of 73.3%. While *Kapoor et al*.[79] reported 80 and 63% of patients in the external fixation group and the volar plating group, respectively, to have good or excellent outcomes, *Gradl et al*.[80] reported 100 and 97.5% of patients in these two groups to have good or outstanding results, respectively.

Samant et al.[] found that 74% of the cases were positive. Our results were comparable to Mahajan's, who reported 91% excellent and good clinical results with MIPO technique in 20 patients with distal tibia fractures while 9% had a fair results.[81] According to Teeny and Wiss' clinical rating for the ankle, 90% of patients in the series by *Ahmed et al*.[73] had excellent and good results while 10% had a fair or poor results, with no significant difference between both treatment groups. In the case of distal tibia fractures, *Webb et al*.[] observed a functional result after MIPO that did not substantially vary from that of the general population.[82]

According to *Merchant and Dietz*.,[83] the mean ankle assessment score at the end of one year using the Iowa ankle score was 78 (range from 63-82) and this correlates to an overall satisfactory performance. Donimath et al.[71] reported favourable outcomes were seen in 83.33 percent of the cases with minimally invasive percutaneous plate osteosynthesis.

Complications

We found in the current investigation that there was no significant difference in the distribution of Complications between External fixator and Plating groups. *Anant S et al*.[70] reported that out of a total of 15 patients, one patient in each of two groups developed wrist joint stiffness and delayed union. The open reduction and internal fixation with plating group had one patient develop wrist joint stiffness and delayed union while the closed reduction and external fixation group had one patient develop wrist joint stiffness and delayed union as well as broken implant in situ and pin tract infection. The degree of stiffness in the wrist joint was evaluated during the third and final follow-up period (six months), and delayed union was evaluated during the second follow-up period (six weeks), where two patients experienced delayed union, one in each group. One of the patients in the external fixator group had an intra-operative breakage of their Shanz pin; nevertheless, the pin was not removed from its position in the patient's body.

Open reduction and internal fixation (ORIF) has resulted to varying outcomes for high energy distal tibia fractures, according to *Beytemür et al*.[67] The decrease is maintaining its momentum and is having a discernible and direct effect on the therapeutic modalities that are made available to persons of varying ages. According to the findings, fewer than 5% of the patients detected had an infection that might potentially affect the healing process.[84]

According to several accounts, there was a significant risk of complications while using ext repair.[85-88] According to Anderson et al., out of the 24 patients who were treated with ext fix, 16 of them had problems. These issues ranged from infections to superficial nerve neuropraxia.[85] Pin tract infections affected nine patients, median and superficial radial neuropathies affected five patients, pin loosening affected four patients, and loss of reduction affected four patients (2 patients). According to the results of our research, 10 of the 17 individuals in the Ext. fix group ended up developing complications. Ext. fix patients had a

variety of issues, including as pin-site infections (three patients), wrist stiffness (three patients), hand shoulder syndrome (one patient), and superficial nerve neuropraxia (one patient) (2 patients). Additionally, Hutchinson et al. reported a complication rate of 45%, of which 50% were regarded as severe or substantial.[89] Pin tract infections, radial neuritis, and complicated regional pain syndrome were, once again, the most prevalent types of complications. In the current research, complications occurred in the course of therapy for 37.1% of the patients in the Ext. fix group and 31.1% of the patients in the ORIF group.

Both *Yih-Shiunn Lee et al*.[37] and *Jensen et al*.[90] reported 9% superficial infections in a case series of one hundred and five patients treated with ORIF. Both groups used the ORIF technique. Yih-Shiunn Lee et al.[37] had a superficial infection rate of 8% in distal tibia fractures treated using the ORIF technique. The rate of wound complications that was reported by *Guo et al*.[76] and Yong chuan Li et al.[91] who used the MIPO method was 14.6% and 19% respectively, which is deemed to be higher than the reported incidence in our MIPO group, which was only 2.5%.

Kloen et al.[92] were the first to employ the locking compression plate as an external fixator. They referred this method as "supercutaneous plating." Traditional bar-Schanz pin fixators are replaced by external locking plate fixators, which are low-profile external fixators with angular stable screw fixation. These fixators make it easier to mobilise the patient, provide greater comfort, and have superior aesthetics than bar-Schanz pin fixators. Zhang et al. investigated the efficacy of one-stage external locking plate fixation in the treatment of 116 tibial fractures.[93] The mean fracture healing periods for proximal, shaft, distal, and multisegmental tibial fractures were 12, 20, 14, and 24 weeks, respectively. The researchers Luo et al. performed a comprehensive analysis of 12 trials and discovered that external locking plate fixation produced good functional results and union rates while also having minimal complication rates.[94]

According to the findings of the research conducted by *Kaempffe et al*.,[95] some of the recognised problems of external fixation include infections in the pin tract, joint stiffness in the wrist, delayed union, and damaged implants. The surgical treatment of distal radius fractures is negatively impacted by excessive distraction of the external fixator and extended fixation, both of which may result in a number of problems. In a research carried out by Rozental and colleagues, the incidence of complications was found to be 8.7% in the group that had open reduction and internal fixation, whereas the rate was 27% in the group that underwent closed reduction and percutaneous pin fixation.[96] In their research, Richard and colleagues came to the conclusion that there was a lower overall incidence of problems in the group that received volar plates as opposed to the group that received external fixators.[97]

Infection and skin necrosis are two of the most common wound complications that a trauma surgeon may face while treating this kind of fracture.[98-100] Wound issues are often among the most frustrating complications for the patient. The risk of wound complications is increased when extensive soft tissue dissection is combined with open reduction and internal fixation.[73]

SUMMARY

Summary

The study findings can be summarized as follows:

- There was no significant difference in mean age between External fixator and Plating groups.
- There was no significant difference in the distribution of males and females between External fixator and Plating groups. There were 76.7% males and 23.3% females.
- There was no significant difference in mean Surgical time between External fixator and Plating groups.
- There was no significant difference in the distribution of side affected between External fixator and Plating groups. The right side was affected in 76.7% cases and left side in 23.3% cases.
- There was no significant difference in the distribution of side affected between External fixator and Plating groups. The mode of injury was fall among 20.0% and RTA among 80.0% cases.
- The mean KATZ Activity of Daily Living Score was significantly more among Plating group compared to External fixator group.
- There was no significant difference in the distribution of Complications between External fixator and Plating groups.
- KATZ Activity of Daily Living Score 6 was significantly more among Plating group compared to External fixator group.

CONCLUSION

Conclusion

Both External Fixation and LCP are very helpful strategies to have in your toolbox. When compared to the LCP approach, LCP shortens the length of time it takes for the bones to unite.

When compared to the external fixation approach, LCP leads in less scar tissue development and has a shorter operating duration, which both contribute to a reduction in the likelihood of post-surgical complications.

It is possible to think of the treatment with an LCP for comminuted intraarticular fractures of the distal tibia as being advantageous and having a positive impact on the process of providing the necessary support to patients. This is as a result of the fact that one may regard the therapy to be advantageous in certain circumstances. An accurate examination of the patient's health issues and the treatment provided is beneficial to the management of the operations.

The goal of minimally invasive locking plate osteosynthesis is to minimise surgical tissue damage while also assisting in the preservation of periosteal vascular integrity and osteogenic fracture haematoma. Therefore, we have reached the conclusion that the use of a locking compression plate for the treatment of intra-articular and extra-articular fractures of the distal tibia by minimally invasive approach in conjunction with fibular fixation is better modality.

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Case History Proforma

Date:

Name: Age:

Weight: Height: BMI:

OPD Reg No: Occupation:

Address:

Socio-economic status:

Chief Complaint:

H/o Present Illness:

Medical History:

Treatment/Drug history:

Radiological Investigations:

INTERVENTION GROUP:

KATZ ctivity of Dily Living Score:

Final Diagnosis:

Treatment Plan:

सूचित सहमति

रोगी का नाम: आयु:

पता: फोन नंबर:

क्र.सं.: दिनांक:

मुझे हकदार अध्ययन का विवरण समझाया गया है ““COMPARATIVE ANALYSIS OF THE FUNCTIONAL OUTCOME OF COMMINUTED INTRA-ARTICULAR FRACTURES OF DISTAL TIBIA FIXED USING EXTERNAL FIXATOR vs LOCKING PLATE

”. अध्ययन के संबंध में मेरे प्रश्नों का उत्तर मेरी समझ में आने वाली भाषा में मेरी संतुष्टि के अनुसार दिया गया है।

मैं समझता हूं कि मुझे किसी भी समय अध्ययन से हटने और किसी विशेष प्रश्न का उत्तर देने से इनकार करने का अधिकार है।

मैं समझता हूं कि इस अध्ययन में मेरी भागीदारी गोपनीय है और कोई भी जानकारी जो मुझे पहचान सकती है, विश्लेषण में और इस अध्ययन पर आधारित किसी भी रिपोर्ट में उपयोग नहीं की जाएगी।

मैं इसके द्वारा हकदार अध्ययन में अपनी सहमति प्रदान करता हूं “COMPARATIVE ANALYSIS OF THE FUNCTIONAL OUTCOME OF COMMINUTED INTRA-ARTICULAR FRACTURES OFDISTAL TIBIA FIXED USING EXTERNAL FIXATOR vs LOCKING PLATE”

रोगी के हस्ताक्षर/अंगूठे का निशान

साक्षी के हस्ताक्षर/अंगूठे का निशान

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